

UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

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U.S. DISTRICT COURT
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TX EASTERN-MARSHALL

Accolade Systems LLC, a Texas Limited
Liability Company,

Plaintiff,

v.

Micron Technology, Inc., and
Aptina Imaging, Inc.

Defendants.

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BY _____

Case No.: 2 - 09 CV - 086 TJW/CE

DEMAND FOR JURY TRIAL

PLAINTIFF'S ORIGINAL COMPLAINT FOR PATENT INFRINGEMENT

Plaintiff Accolade Systems LLC ("Accolade") alleges against Micron Technology, Inc. ("Micron"), and Aptina Imaging, Inc. ("Aptina") as follows:

NATURE OF THE ACTION

1. This is an action for patent infringement arising out of infringement of Accolade's U.S. Patent No. 7,463,298 issued on December 9, 2008 (the "298 Patent"). This action is brought to remedy the infringement of the '298 Patent by Defendants under 35 U.S.C. § 271.

THE PARTIES

2. Plaintiff Accolade is a Texas limited liability company duly organized and existing under the laws of the State of Texas. Accolade is the owner of all right, title, and interest in the '298 Patent, which is entitled "Method and Apparatus for Detecting Camera Sensor Intensity Saturation."

3. Upon information and belief, Micron Technology, Inc. is a Delaware corporation that maintains its principal place of business at 8000 S. Federal Way, Boise, Idaho 83716. Upon

information and belief, Micron may be served with process by serving its registered agent, Corporation Service Company, 2711 Centerville Road; Suite 400, Wilmington, Delaware 19808.

4. Upon information and belief, Aptina Imaging, Inc. is a subsidiary of Micron and is a Delaware corporation that maintains its principal place of business at 3080 North 1st Street, San Jose, California 95134.

5. Accolade is informed and believes, and on that basis alleges, that Defendants have infringed and continue to infringe the '298 Patent under 35 U.S.C. § 271 within this District.

JURISDICTION AND VENUE

6. This action arises under the patent laws of the United States, 35 U.S.C. §§ 101, *et seq.* This Court has jurisdiction over the subject matter of this action pursuant to 28 U.S.C. §§ 1331 and 1338(a) and (b). Venue is proper in this District pursuant to 28 U.S.C. §§ 1391(b) - (c) and 1400(b) in that Defendants have and continue to infringe under 35 U.S.C. § 271 upon the '298 Patent owned by Accolade in this District.

BACKGROUND FACTS

7. A true and correct copy of the '298 Patent is attached hereto as Exhibit 1, and incorporated by this reference.

8. Defendants are believed to have incorporated Accolade's patented technology in products and/or services developed and/or marketed by Defendants, including those products known as Micron MI220 image sensor, Aptina MT9D014 CMOS image sensor, Aptina MT9D012 CMOS image sensor and other products or services which provide for detecting camera sensor intensity saturation, without authorization from Accolade. Such sensors are incorporated into various consumer products, including cellular telephones such as the Apple iPhone, which are being sold and/or offered for sale in this District.

9. Accolade is informed and believes, and on that basis alleges, that Defendants have and continue to infringe the '298 Patent under 35 U.S.C. § 271 through Defendants' manufacturing, use, advertising, sales, and marketing efforts.

CLAIM FOR RELIEF

(Patent Infringement)

10. Plaintiff repeats and realleges the allegations set forth in Paragraphs 1 through 10, above, as if set forth in full herein.

11. The '298 Patent was duly and legally issued on December 9, 2008. Plaintiff is the owner of all right, title, and interest in the '298 Patent, together with all rights to sue and recover damages for all accrued and other patent infringements, whether past, present, or future.

12. Accolade is informed and believes, and on that basis alleges, that Defendants are now infringing at least one claim of the '298 Patent under 35 U.S.C. § 271 by making, using, offering to sell, importing into, or selling within this District and elsewhere in the United States, without license or authority from Plaintiff, certain products and/or services or technologies that infringe at least one claim of the '298 Patent.

13. Accolade is informed and believes, and on that basis alleges, that by reason of the above acts, Defendants have caused, are causing, and, unless enjoined and restrained by this Court, will continue to cause Plaintiff great and irreparable injury to, among other things, the value of the '298 Patent and Accolade's prospective business relations, all of which cannot be adequately measured or compensated in money damages. Plaintiff has no adequate remedy at law and is entitled to injunctive relief enjoining and restraining Defendants, their officers, agents, servants, employees, partners, contractors, licensees, affiliates, and attorneys, and those persons in active concert or participation with them, including but not limited to Defendants' distributors, resellers, and

customers, from further manufacture, sales, offers for sale, importation, other distribution, or use of any infringing product and/or service.

14. As a direct and proximate result of Defendant's infringement of one or more claims of the '298 Patent, Plaintiff has been, and continues to be, irreparably harmed and otherwise severely damaged in an amount yet to be determined. Accolade is informed and believes, and on that basis alleges, that, unless enjoined, Defendants will continue their infringing activities.

PRAYER FOR RELIEF

WHEREFORE, Plaintiff prays for relief against Defendant as follows:

1. On the Claim for Relief, pursuant to Fed. R. Civ. P. 65, for preliminary and permanent injunctive relief enjoining Defendants, their officers, agents, servants, employees, partners, contractors, licensees, affiliates, and attorneys, and those persons in active concert or participation with them, including but not limited to Defendants' distributors, resellers, and customers, from further manufacture, sales, offers for sale, importation, other distribution, or use of any infringing products and/or services;

2. On the Claim for Relief, for compensatory damages in an amount to be proven at trial and for attorneys' fees and costs;

3. For pre-judgment interest at the rate as allowed by law;

4. For Plaintiff's attorneys' fees and costs as allowed by law; and,

5. For such other and further relief as the Court deems just and proper.

PLAINTIFF'S DEMAND FOR JURY TRIAL

Pursuant to Fed. R. Civ. P. 38, Plaintiff hereby demands trial by jury of all issues triable by jury.

Respectfully submitted,

A handwritten signature in black ink, reading "Carl Roth", written over a horizontal line.

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State Bar No. 17312000

AMANDA A. ABRAHAM

State Bar No. 24055077

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115 Wellington, Suite 200

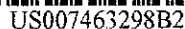
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ATTORNEYS FOR PLAINTIFF

ACCOLADE SYSTEMS, LLC



(10) **Patent No.:** US 7,463,298 B2
(45) **Date of Patent:** Dec. 9, 2008

(54) METHOD AND APPARATUS FOR
DETECTING CAMERA SENSOR INTENSITY
SATURATION

6 275 259 B1 *	8/2001	Gowda et al.	348/229 1
6 906 745 B1	6/2005	Fossum et al	

* cited by examiner

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(US)

Primary Examiner—James M Hannett

(74) *Attorney, Agent, or Firm*—TIPS Group

(73) Assignee: **G&H Nevada-Tek**, Los Altos, CA (US)

(57) **ABSTRACT**

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 473 days

A method for detecting intensity saturation of a light sensor includes monitoring an electrical signal from a light sensor for detecting an intensity saturation condition of at least one pixel of the light sensor, converting the electrical signal to a digital signal, imposing a reserved bit combination on the digital signal indicating the intensity saturation condition of the pixel, and transmitting a control signal in response to the digital signal to compensate for the intensity saturation condition of the pixel. Alternatively stated, the method includes monitoring pixel data from an output of a light sensor to determine a number of pixels at saturation and a number of pixels near saturation comparing the number of pixels at saturation to a predetermined first threshold number, comparing the number of pixels near saturation to a predetermined second threshold number, reprogramming the light sensor to adapt to more brightness if the number of pixels at saturation is above the first threshold number, and reprogramming the light sensor to adapt to less brightness if the number of pixels near saturation is below the second threshold number. An apparatus for detecting intensity saturation of a light sensor includes a saturation detector for detecting and measuring an intensity saturation condition of at least one pixel of a light sensor, the intensity saturation condition of the pixel being at saturation upon receiving light with an intensity above a predetermined level, the saturation detector emitting a digital signal with a reserved bit combination indicating the intensity saturation condition of the pixel, and a processor receiving and processing the digital signal from the saturation detector and transmitting a control signal in response to the digital signal to compensate for the intensity saturation condition of the pixel.

(21) Appl No : 10/921,692

(22) Filed: **Aug. 19, 2004**

(65) **Prior Publication Data**

US 2005/0030413 A1 Feb. 10, 2005

Related U.S. Application Data

(63) Continuation of application No. 09/387,068, filed on Aug. 30, 1999, now Pat No. 6,816,200

(60) Provisional application No. 60/098,581, filed on Aug 31, 1998

(51) Int. Cl.
H04N 3/14 (2006.01)
H04N 5/335 (2006.01)

(52) U.S. Cl. 348/302; 348/294

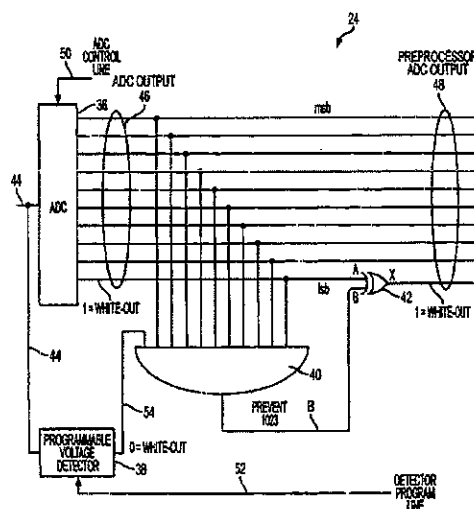
(58) **Field of Classification Search** 348/302,
348/294; 341/155, 161, 169, 170
See application file for complete search history

(56) **References Cited**

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4,860,103	A	8/1989	Azam et al	
5 504,524	A *	4/1996	Lu et al	348/223 l
5 798,519	A *	8/1998	Vock et al	250/206.1
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8 Claims, 5 Drawing Sheets



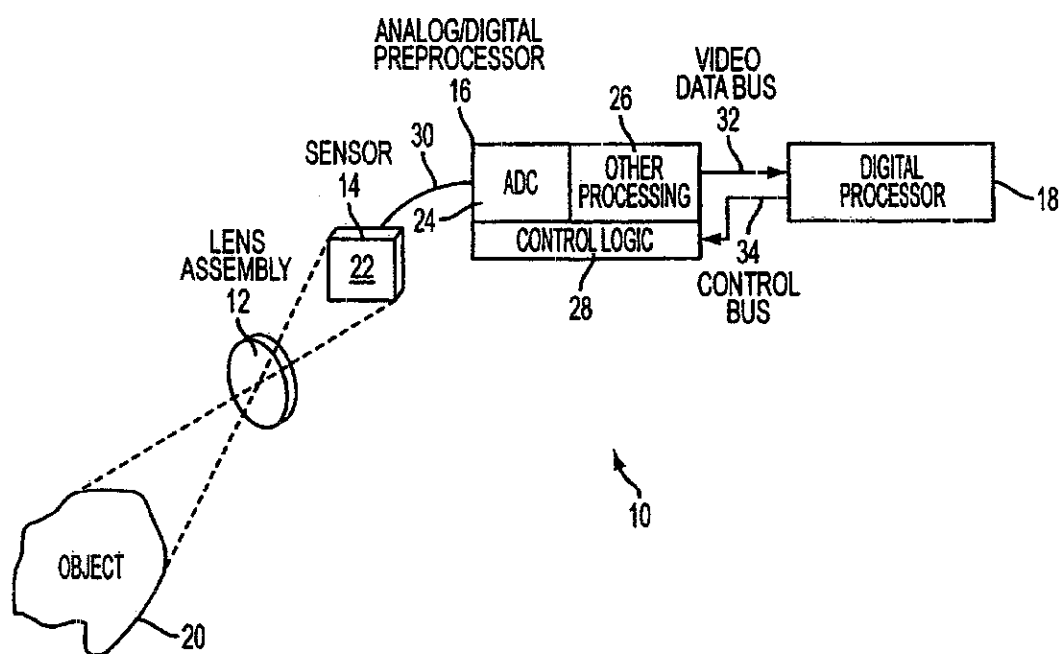


FIG. 1

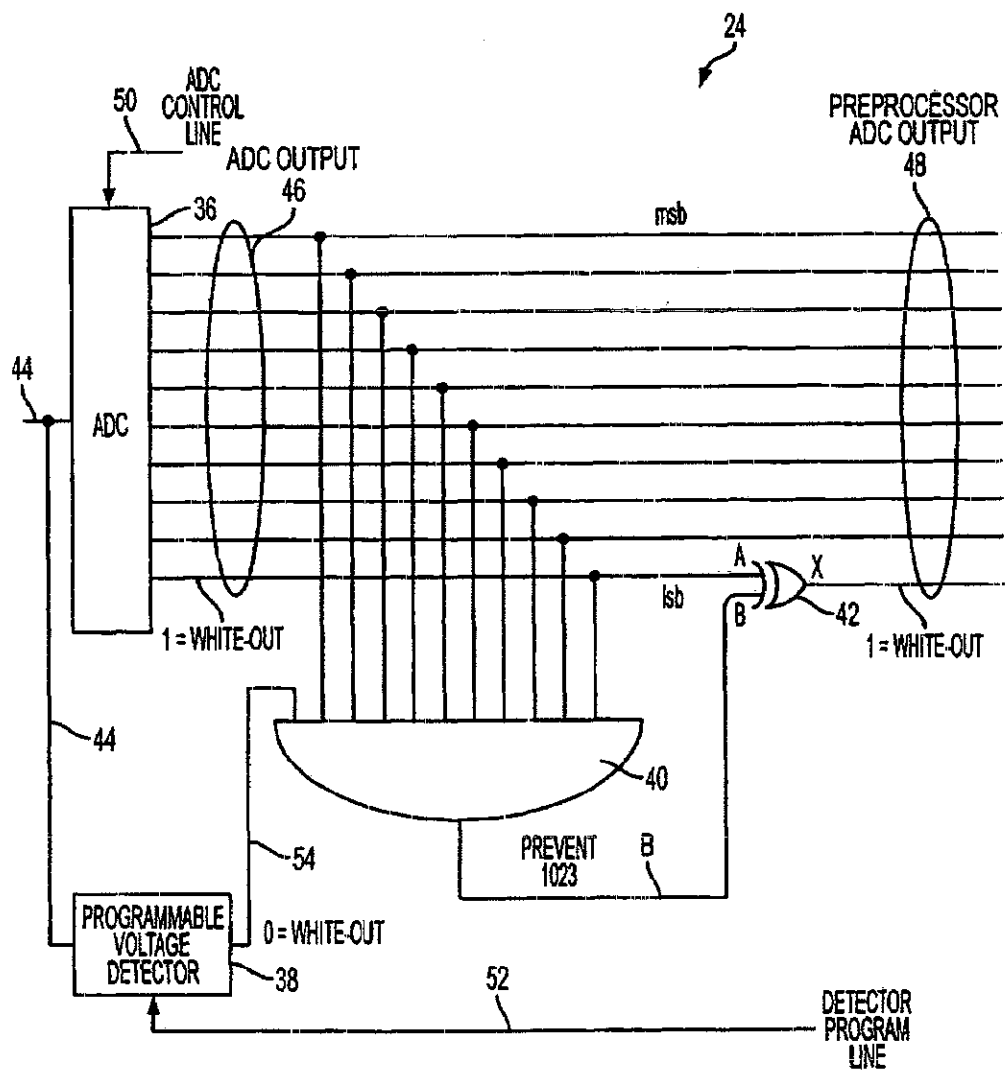


FIG. 2

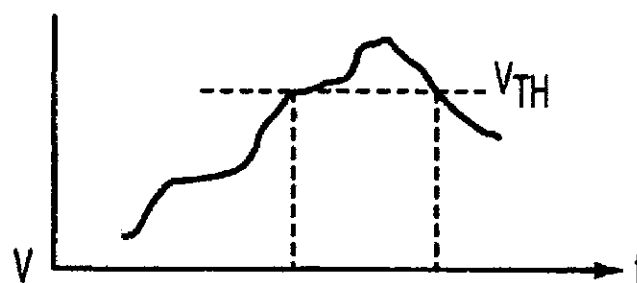


FIG. 3A

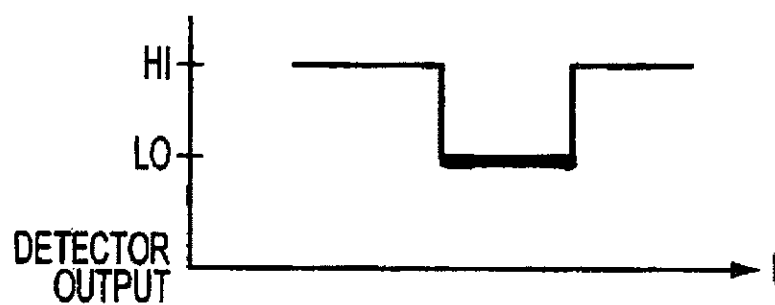


FIG. 3B

A	B	X
0	0	0
1	0	1
0	1	-
1	1	0

FIG. 4

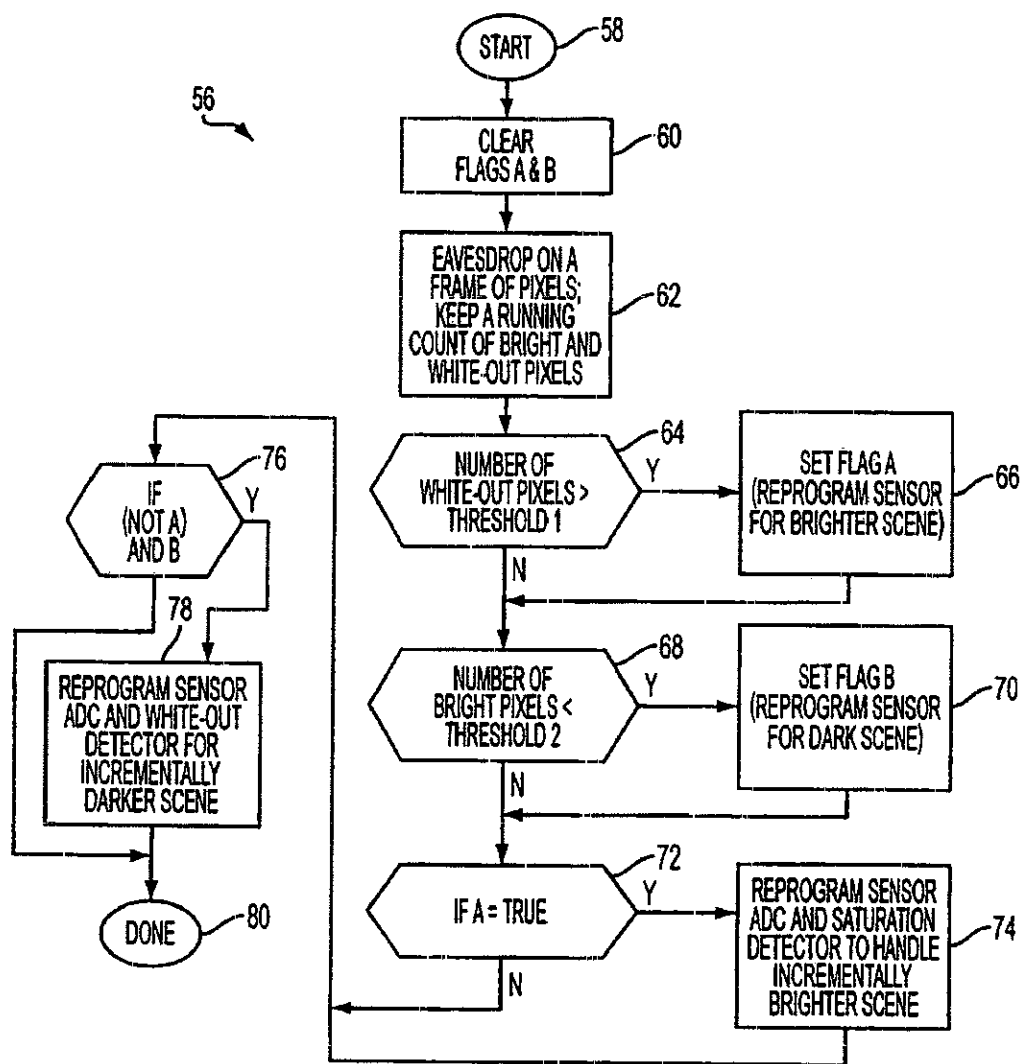


FIG. 5

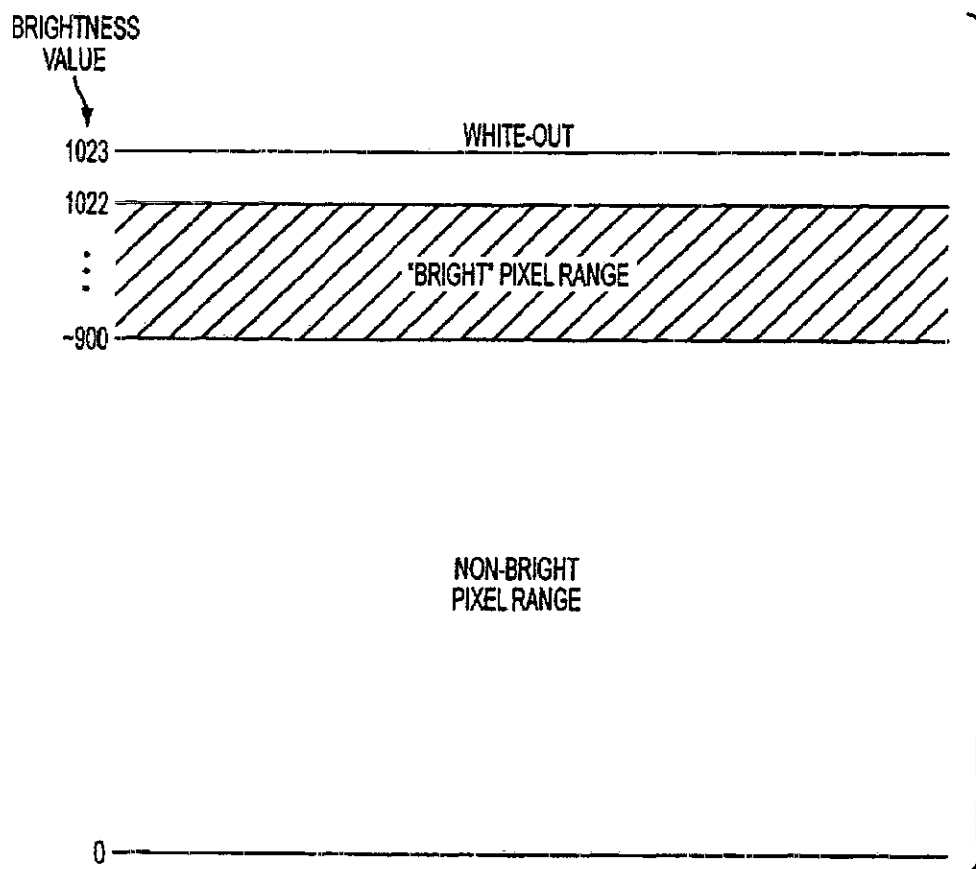


FIG. 6

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METHOD AND APPARATUS FOR DETECTING CAMERA SENSOR INTENSITY SATURATION

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. Ser. No. 09/387,068, filed Aug. 30, 1999 now U.S. Pat. No. 6,816,200, incorporated herein by reference, which claims the benefit of U.S. Ser. No. 60/098,581, filed Aug. 31, 1998, also incorporated herein by reference.

BACKGROUND OF THE INVENTION

This invention relates generally to color digital cameras, and more particularly to the processing of pixel information generated by the sensor of a color digital camera.

Digital color cameras are used with computer or other digital processing systems. Such cameras include a sensor, optics, preprocessing electronics, and a cable or other communication link to transfer data to the digital processing system. Digital cameras are made by Connectix, Intel, and others.

In a conventional digital camera, the sensor is often a charge coupled device (CCD) that produces electrical image signals corresponding to an object producing or reflecting light onto the sensor. The electrical image signals are then processed and recorded on a storage medium such as a memory card or other computer readable medium.

A problem encountered with digital cameras is that the sensor can become saturated when the light intensity exceeds the intensity saturation limit of the sensor. When the light level is above the saturation level of the sensor, all further video information, other than the saturation information, is lost. In the past, this problem has been addressed by attempting to manipulate the amount of light striking the sensor or adjusting the sensor itself.

Some of the prior art has attempted to utilize a light intensity measuring circuit which processes data from the sensor and controls movement of an iris. The iris closes to restrict the amount of incident light striking the sensor and opens to allow more incident light to strike the sensor. However, the movement of the iris is slow compared to other means of intensity adjustment. Furthermore, due to its mechanical nature, the iris often closes more than necessary or doesn't close enough, at which point it must be repositioned. The result is slow correction time and fluctuations in brightness, ending in degradation of picture quality. The latter is especially if utilized with video cameras, where the fluctuating brightness is captured. Furthermore, a solitary bright light can cause the iris to close so much that gradation of the dark regions becomes compressed and deteriorated. The same occurs when direct strong light is incident, such as in the case of strong rear lighting.

In a system in which an electric charge corresponding to an amount of light received is accumulated on a photodiode and passed to an n-layer substrate of the sensor, other prior art has sought to draw away excess voltage that flows from the photodiode of the sensor when an excessive amount of light is received. For example, a p-layer is positioned between the photodiode and substrate of the sensor and grounded. This applies a reverse bias voltage to the substrate and p-layer so that a depletion layer is formed between the photodiode and the substrate. Surplus electric charges that overflow from the photodiode, due to an excessive amount of received light, are absorbed in the depletion layer. The voltage of the substrate is

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then adjusted to accommodate bright and dark scenes. A great disadvantage is that signals from the photodiodes are disrupted in that they must now pass through a layer specifically designed to absorb such signals. Another disadvantage of this is that the voltage of the substrate must be preset based on estimated light conditions, especially disadvantageous for capturing moving video. Another disadvantage is that the voltage of the entire substrate must be changed, not just for the portion receiving the excessively intense light. This results in poor picture quality in that bright areas of light are compensated for but dim spots are not.

Another problem encountered with digital cameras is that picture quality drops as the light intensity falls below a certain level. Furthermore, even images in a dark portion of a scene can be hard to observe if a direct strong light is incident in the scene. The prior art has attempted to correct such problems by monitoring signals from the sensor that have been separated into red, green and blue component signals and have also been gamma corrected. Then, a dark area proportion in a whole picked up image is detected. Next, a portion of the processed original signal is modified to stretch the dark signal region to improve the gradation of the dark area. The processed original signal and the modified signal are combined to output a resultant gradation improved signal. The disadvantage of this prior art method is that separation and gamma correction of the original signal are performed before the dark area is detected. This reduces the accuracy of the detection of the dark area. Further, the dark area is estimated from the processed original signal as a whole, not on a pixel by pixel basis, further reducing the accuracy of the detection of the dark area and making correction of the dark area more difficult.

SUMMARY OF THE INVENTION

In the present invention, an electrical signal from a light sensor is monitored to detect an intensity saturation condition of at least one pixel of the light sensor. The intensity saturation condition of the pixel is at saturation upon receiving light with an intensity above a predetermined level and below saturation upon receiving light with an intensity below a predetermined level. The electrical signal is converted to a digital signal. A reserved bit combination is imposed on the digital signal indicating the intensity saturation condition of the pixel. A control signal is transmitted in response to the bit combination of the digital signal to compensate for the intensity saturation condition of the pixel. An analog to digital converter can be utilized to convert the electrical signal to the digital signal. The analog to digital converter may be programmable to receive electrical signals of different intensities from the light sensor.

Monitoring the electrical signal may include determining whether a voltage of an electrical signal from the light sensor is above a predetermined level. Further, the control signal may reset the predetermined level of voltage. The analog to digital converter may form part of an analog to digital circuit that also includes an AND gate and an OR gate.

The electrical signal from the light sensor may include a series of signals scanned from preselected pixels from an array of pixels of the sensor, or may include a series of signals scanned pixel by pixel from the array of pixels of the sensor.

In one aspect of the invention, an integrated circuit may perform the aforementioned actions. The integrated circuit may form part of a camera module. Optionally, the camera module may further include the light sensor, a lens assembly aligned with the light sensor, and a printed circuit board supporting the integrated circuit.

In another embodiment of the present invention, pixel data from an output of a light sensor is monitored to determine a number of pixels at saturation. The number of pixels at saturation are compared to a predetermined threshold number. The light sensor is reprogrammed to adapt to more brightness if the number of pixels at saturation is above the threshold number. The light sensor may also be programmed to adapt to less brightness if the number of pixels at saturation is below the threshold number.

A saturation detector may be coupled to the light sensor for detecting an intensity saturation condition of the light sensor. The saturation detector can be reprogrammed to adapt to more brightness if the number of pixels at saturation is above the threshold number. The monitoring of the pixel data may be performed without disturbing data flow. Optionally, reprogramming of the saturation detector can be performed in predetermined increments.

In yet another embodiment of the present invention, pixel data from an output of a light sensor is monitored to determine a number of pixels near saturation. The number of pixels near saturation are compared to a predetermined threshold number. The light sensor is reprogrammed to adapt to less brightness if the number of pixels near saturation is below the threshold number.

A saturation detector may be coupled to the light sensor to detect an intensity saturation condition of the light sensor. The saturation detector may be reprogrammed to adapt to less brightness if the number of pixels at saturation is below the threshold number. Optionally, reprogramming of the saturation detector may be performed in predetermined increments. The pixel data may also be monitored without disturbing data flow.

In still yet another embodiment of the present invention, pixel data from an output of a light sensor is monitored to determine a number of pixels at saturation and a number of pixels near saturation. The number of pixels at saturation is compared to a predetermined first threshold number and the number of pixels near saturation are compared to a predetermined second threshold number. The light sensor is reprogrammed to adapt to more brightness if the number of pixels at saturation is above the first threshold number. The light sensor is reprogrammed to adapt to less brightness if the number of pixels near saturation is below the second threshold number.

In one aspect of the invention, a saturation detector may be coupled to the light sensor to detect an intensity saturation condition of the light sensor. The saturation detector can be reprogrammed to adapt to more brightness if the number of pixels at saturation is above the first threshold number, and can be reprogrammed to adapt to less brightness if the number of pixels near saturation is below the second threshold number. Optionally, reprogramming of the saturation detector can be performed in predetermined increments. Also, monitoring the pixel data may be performed without disturbing data flow.

In yet another embodiment of the present invention, a saturation detector detects and measures an intensity saturation condition of at least one pixel of a light sensor. The saturation detector emits a digital signal with a reserved bit combination indicating the intensity saturation condition of the pixel. A processor receives and processes the digital signal from the saturation detector and transmits a control signal in response to the digital signal to compensate for the intensity saturation condition of the pixel.

The saturation detector may include a voltage detector for determining whether a voltage of an electrical signal from the light sensor is above a predetermined level. The voltage detector may be programmable such that the control signal

resets the predetermined level of the voltage. The saturation detector may include an analog to digital converter for converting an electrical signal from the light sensor into a digital signal for indicating the intensity saturation condition of the pixel. Optionally, the analog to digital converter may be programmable to convert electrical signals of different intensities. Also, the analog to digital converter may form part of an analog to digital circuit that also includes an AND gate and an OR gate.

The present invention detects situations where too much light is being received, or too little light is being received. When such conditions are detected, they may be corrected by altering the setting of an ADC and a voltage detector on a preprocessor, and by altering the gamma correction and color correction on a host or digital processor. Such gamma and color correction can take place on a pixel by pixel basis.

An intensity saturation condition for each of the pixels of the light sensor may be detected, and a reserved bit combination may be imposed on an ADC output bus to inform a digital processor of the saturation condition for some or each of the independent pixels. A digital processor can use this information to control the ADC to compensate for the saturation condition.

Because the saturation condition of individual pixels is scanned, gamma and color correction may take place on a pixel-by-pixel basis, providing the advantage of producing excellent picture quality free of excessively bright and dim areas. Further, random sampling may be used to reduce the consumption of electric power.

These and other advantages of the present invention will become apparent to those skilled in the art upon a reading of the following descriptions of the invention and a study of the several figures of the drawing.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram of a camera system including an apparatus for detecting camera sensor intensity saturation;

FIG. 2 is a schematic of the camera sensor intensity saturation apparatus of FIG. 1;

FIGS. 3a and 3b shows a waveform illustrating operation of the voltage detector shown in FIG. 2;

FIG. 4 is a table of the logic of the XOR gate;

FIG. 5 is a flow diagram for a process implemented by the digital processor of FIG. 1 to control the ADC of FIG. 2 in response to the detection of an intensity saturation condition of the sensor; and

FIG. 6 is a diagram illustrating the brightness value ranges associated with pixel data from a camera sensor.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In FIG. 1, a digital video camera system 10 includes a lens assembly 12, a sensor 14 for converting incident light into a video signal, an analog/digital preprocessor 16, and a digital processor 18. The lens assembly 12 focuses an image of an object 20 on a surface 22 of the sensor 14. Often, the lens assembly 12, sensor 14, and preprocessor 16 are housed within a common housing or enclosure (not shown). The digital processor 18 may, in some circumstances, also be housed within the same enclosure. However, in many instances the digital processor 18 can be an external processor, such as a microcomputer.

The lens assembly can be in any suitable form, including a simple plastic lens assembly or a complex multi-lens optical assembly, depending upon the application. The sensor 14 is

one of a variety of solid-state sensors made by, for example, charge coupled device (CCD) or complementary metal oxide semiconductor (CMOS) technologies.

The preprocessor 16 preferably includes a number of sections including an analog to digital converter (ADC) 24, other processing circuitry 26, and control logic 28. Analog sensor data is input into the preprocessor 16 over an analog bus 30, and digital sensor data is output from the preprocessor 16 over digital bus 32. The digital processor 18 receives the digital "video" data over bus 32, and provides control signals to the preprocessor 16 over control bus 34. As will be discussed in greater detail below, the preprocessor 16 of the present invention detects an intensity saturation condition on the analog "video" bus 30, informs the digital processor 18 of the condition by a particular bit pattern over the digital video bus 32, and then the digital processor 18 provides appropriate control signals over the control bus 34 to compensate for the saturation condition.

In FIG. 2, the ADC circuit 24 of the present invention is shown in greater detail. More particularly, one embodiment of ADC circuit 24 includes a programmable ADC 36, a programmable voltage detector 38, an AND gate 40, and an exclusive or (XOR) gate 42. The ADC in the present example receives an analog input on a line 44 and has ten (10) output lines 46 as the ADC output. These outputs range from the most significant bit (msb) to the least significant bit (lsb). The circuitry and logic of the ADC circuitry 24 imposes a particular bit pattern on the preprocessed ADC output 48 when the intensity level on the line 44 exceeds a predetermined value or threshold, or is otherwise detected to be in saturation. The particular bit pattern chosen in this embodiment is "1111111111" in binary or "1023" in decimal.

The ADC 36 is a conventional programmable ADC circuit that takes the analog signal on line 44 and converts it to digital signal on bus 48. Therefore, this ADC has ten bits of resolution. Other embodiments have more, none or fewer bits of resolution. The signal on line 46 is a series of signals scanned pixel-by-pixel from the array of pixels on the surface 22 of sensor 14. The ADC 36 can be controlled as far as sensitivity to different intensity ranges via an ADC control line 50 forming a part of the control bus 36 from the digital processor 18.

The programmable voltage detector 38 is used to detect the voltage level on line 44 to determine when a particular pixel is saturated. When the pixel is saturated, the ADC output is set to all 1's to signal a saturation condition for that pixel. It should therefore be noted that the saturation detection is on a pixel-by-pixel basis, and that the digital processor 18 can act upon the pixel saturation information to control the ADC via ADC control line 50.

The actual threshold V_{TH} detected by the detector 38 can be set by a detector program line 52. More particularly, the detector 38 can include a register that can be programmed via line 52 to determine the threshold voltage V_{TH} on line 44 which will create a digital output signal on a line 54. In the present embodiment, the digital output signal on line 54 is "1" or "HI" when the voltage V on the line 44 is below V_{TH} , and the digital output signal on line 54 is "0" or "LO" when the voltage V on the line 44 is above V_{TH} . Therefore, in this embodiment, a LO signal on the line 54 indicates a saturation or "whiteout" condition. FIG. 3 illustrates the relationship between the voltage V on line 44 and the output of the detector 38. Of course, other circuits can be used to determine a saturation condition for the sensor array. Voltage threshold detection is only one method for accomplishing this task.

The AND gate 40 has 11 inputs, where one input is coupled to the output line 54 of the detector 38, and where the remaining 10 inputs are coupled to the ADC output bus 46. There-

fore, the output of the AND gate 40 on a line B will be "1" or "HI" only when the bus 46 is at 1111111111 (in binary) and when the voltage V on input line 44 is below V_{TH} . Under these conditions, the output X of XOR 42 is forced to 0 (LO), forcing the output of preprocessed ADC output bus 48 to 111111110. This is because the output on the bus 48 of 1111111111 is reserved to signal a saturation condition.

When the voltage V on line 44 is above the threshold voltage V_{TH} , the output of the ADC on bus 46 will be 1111111111, and the signal on line 54 will be 0. This will cause the output of the AND gate 40 to go "LO" or "0", allowing the output of the XOR 42 to become the same as the lsb on bus 46, i.e. to become 1. The output bus 48 will therefore be 1111111111, signaling the saturation of that pixel. When the output on the bus 46 is other than 1111111111, the output of the AND gate 40 will be 0, and the data on the bus 48 will be the same as the data on the bus 46.

The logic of the XOR gate 42 is shown in FIG. 4. That is, when the input on line B to the XOR gate 42 is LO, then the output of the XOR gate is the same as the input on line A. The condition where A is LO and B is HI is impossible, since a LO signal on A would force B LO as well. When both A and B are both HI, then x is forced LO by the XOR gate 42.

In FIG. 5, a process 56 for detecting camera sensor intensity saturation as implemented by a digital processor 18 begins at 58, and the flags "A" and "B" are cleared in an operation 60. Then, in an operation 62, the process "eavesdrops" on a frame of pixels; keeping a running count of bright and whiteout pixels. By "eavesdrops" it is meant that the process does not disturb the data flow, but merely monitors the pixel data as it is received. This is usually accomplished by using a few registers to keep count of certain pixel types, including bright and whiteout pixels. A "bright" pixel is near but not yet at, saturation. A "whiteout" pixel is at saturation and is designated by "1111111111" in this example.

Next, in a decision operation 64, it is determined whether the number of whiteout pixels are greater than a threshold1 number. A typical threshold1 number for whiteout pixels depends upon the brightness of a scene, but for an average scene, the threshold1 may be about 20 whiteout pixels. If it is greater than the threshold1, an operation 66 sets flag A to indicate that the preprocessor 16 should be reprogrammed for a brighter scene. This is accomplished, at least in part, by reprogramming the ADC 50 and the voltage detector 38.

Operation 68 determines whether the number of bright pixels is less than a threshold2, which is typically about 50, but which again is dependent upon the scene. If it is less than the threshold, operation 70 sets flag B to flag that the preprocessor 16 should be reprogrammed for a darker scene. This, again, is accomplished in part by reprogramming the ADC 50 and the voltage detector 38.

Operation 72 determines whether the A flag has been set. If so, operation 74 reprograms the ADC 50 and the voltage detector 38 to handle an incrementally brighter scene. The ADC 50 is programmed to cover a wider range of voltages with the same number of bit combinations. The voltage detector 38 is reprogrammed to raise the threshold voltage V_{TH} . This is accomplished incrementally to avoid making too large of a step.

Operation 76 determines whether the B flag is set and the A flag is not set. If these conditions are true, then an operation 78 reprograms the sensor ADC 36 and the voltage detector 38. More particularly, the ADC 50 is programmed to cover a narrower range of voltages for the same number of bit combinations. The voltage detector 38 is reprogrammed to lower the threshold voltage V_{TH} . This is accomplished incremen-

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tally to avoid making too large of a step. The process 56 is then completed at 80 awaiting the next frame of data.

FIG. 6 illustrates the different categories of brightness in the present example. Here, the value 1023 represents white-out, while values of about 900 to 1022 represent the bright pixel range. Values below about 900 represent the non-bright pixel range.

It will therefore be appreciated that the process and apparatus of the present invention detects a saturation condition and forces a digital output bus to a predetermined pattern to indicate the saturation condition. The process and apparatus of the present invention prevents the predetermined pattern from occurring when the saturation condition is not present.

It will further be appreciated that the present invention detects situations where too much light is being received, or too little light is being received. When such conditions are detected, they are corrected by altering the setting of an ADC and a voltage detector on a preprocessor, and by altering the gamma correction and color correction on a host or digital processor, as will be appreciated by those skilled in the art.

It should be noted that the logic used in the example of FIGS. 1 and 2 and the processes illustrated in FIG. 5 exemplify only one implementation of the present invention. Those skilled in the art will appreciate that other logic components can accomplish the design goals of the present invention. For example, NAND gates, OR gates, inverters and other forms of logic can be used to accomplish the goals of the invention, which includes the detection of a saturation condition, the imposition of a particular bit pattern on the video output bus, and the correction of the saturation condition in response thereto. Likewise, alternative process operations can be used to implement the present invention.

What is claimed is:

1. A digital camera device comprising:
a multi-pixel light sensor;
an analog-to-digital converter circuit coupled to an output of said multi-pixel light sensor; and

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a lighting condition adjustment circuit coupled to an output of said analog-to-digital converter and operative to adjust an operating parameter of said analog-to-digital converter to compensate for detected lighting conditions;

wherein said lighting condition adjustment circuit counts a number of digital outputs of said analog-to-digital converter which satisfy a condition and creates an incremental analog-to-digital converter control signal to be applied to said analog-to-digital converter to adjust said operating parameter.

2. A digital camera device as recited in claim 1 wherein said condition is satisfied by at least one of being above a threshold value and equaling said threshold value.

3. A digital camera device as recited in claim 1 wherein said condition is satisfied by at least one of being below a threshold value and equaling said threshold value.

4. A digital camera device as recited in claim 3 wherein said threshold value is a first threshold value, and said condition is further satisfied by at least one of being above a second threshold value and equaling said second threshold value.

5. A digital camera device as recited in claim 1 further comprising a lens associated with said multi-pixel light sensor.

6. A digital camera device as recited in claim 5 further comprising a display for displaying a representation of an image focused on said multi-pixel light sensor by said lens.

7. A digital camera device as recited in claim 5 further comprising a communication link for transmitting a representation of an image focused on said multi-pixel light sensor by said lens.

8. A digital camera device as recited in claim 5 further comprising a storage medium for storing a representation of an image focused on said multi-pixel light sensor by said lens.

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